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Analysis of Activities in Self Organisable Wireless Sensor Network

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***Abstract*— This Networks considered in this paper consist of tiny energy constrained commodity sensors massively deployed in an area of interest. In a wireless sensor network, energy conservation is the primary design goal. Here a method is proposed to manage the spontaneous organization of sensor activity in ad hoc wireless sensor network systems. The small wireless sensors exchange messages to coordinate responses to requests for sensing data, and to control the fraction of sensors which are active. This method can be used to manage a variety of sensor activities. In this way, one can use it for reducing the power consumption by battery operated devices only when low resolution sensing is required. This in turn increases the operation lifetimes.**

***Keywords*— Network, WSN, Lifetime, Self organisable, Activity.**

I. INTRODUCTION

New and recent developments in microelectronics have made possible the development of small, low power coin size wireless sensor devices with the ability to handle sophisticated communication protocols. There is a growing interest in applications of the devices in distributed sensor networks. However, these systems require the development of new control and management methods. Key issues distinguishing wireless sensor networks from conventional computer networks are the large numbers of devices, unreliable operating conditions, and severe constraints on operating resources, as well as functional architectures with an emphasis on sensing and collecting data rather than processing and using data [1]. Moreover, wireless sensor devices may have limited battery power sources. Such sensor systems need to act somewhat like living systems – they have to integrate sensing, communication and self maintenance functions under highly variable conditions, and to make dynamic trade-offs between survival and performance. They should be able to operate with minimal external control using self-organizing mechanisms which support robust operation in the presence of large and varying numbers of other nodes [2-5]. The use of self-organizing methods for coordination of activity in wireless networks has progressed over recent years. A number of recent works have also proposed methods for self-organized coordination of nodes in wireless sensor networks [3-5]. Our aim is to extend self-organization to higher-level sensing system functions, including interaction with users. In this paper we consider wireless sensors which respond on demand to requests for sensing data. We propose a protocol which allows the self-organization of sensor activity to be controlled by the user in such a way that the trade-off between the sensor capacity and operation lifetime can be matched to the sensing needs. In order to create an appropriate management protocol, we chose to build on a proven robust protocol: the management scheme used in the ad hoc mode of the 802.11 medium access protocols. This is used to manage the formation and maintenance of cells, synchronization and power management through sleep cycles. We have built on this method and extended it to management of more general forms of activity in ad hoc wireless sensor systems.

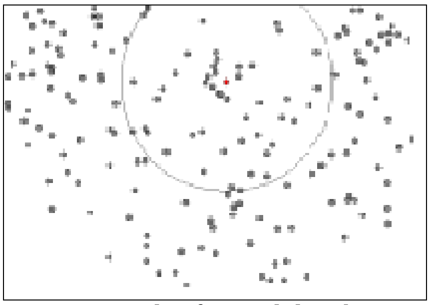

Figure 1: An example of typical distribution of sensor devices and a command node

In this paper, first an overview of our system Design is given. Then we provide a more detailed description of specific features. We also describe a prototype system that has been developed to test the proposed protocol, and discuss issues of stability and performance.

II. OVERVIEW OF SYSTEM

An A distributed system of wireless sensor nodes is taken here, typically distributed in a more or less random way to cover a certain spatial area (Fig. 1). The nodes operate on demand to collect and transmit sensing data. The command node could be a mobile node, such as a PDA held by a human operator. Our system design relates to how the sensors respond to requests for sensing activity from the command node. The basic idea is that depending on the demands of the user, it may not be necessary for all the nodes to be active at the same time. For example, if the nodes are temperature sensors and the user requires only a rough sample, only a fraction of the nodes need to be active. If more nodes are active, more complete sensing data can be acquired, but typically at a cost. The cost could be shorter operating lifetimes, communication congestion or, be excessive processing load. if the processing power of the command node is limited. In our design, we take a lesson from the operation of the ad hoc mode of the 802.11 MAC protocols [6]. According to the Distributed Coordination Function of 802.11, in each beacon interval only one node, the node which chooses the shortest random wait time, transmits a beacon and stays awake. The other nodes which hear the beacon transmission by the first node cancel their own beacon transmission and go to sleep until the next beacon window, when all nodes wake up again. We adopt this mechanism to coordinate not only the wireless medium access activity, but also the sensing activity of the nodes. A summary of the protocol is given in the next section.

III. ACTIVITY MANAGEMENT FOR SELF ORGANISATION

In this section the self organisable protocol which is used to coordinate the wireless sensor devices. The nodes use a beacon mechanism to share timing and cell-ID information, and to manage the switching between active and in-active states. Figure 2 shows the basic timing diagram. The devices cycle between awake and sleep states. An exchange of messages between devices is done when all the devices are awake. When the command node broadcasts a request for sensing activity, typically only a fraction of the nodes are active and hear the command. If it is necessary to get data from the other nodes, the awake nodes buffer the requests and relay the requests to the other nodes in the next all-awake window. In this more than one node can be active, and that the number of active devices can be controlled by the user. The number of active devices can be changed via an activity command-parameter *K*, included with the request for sensing activity. The nodes refer to the value of this activity parameter when they decide whether to be active. The decision whether to be active can be made in two ways according to the value of a command parameter *J*. In each case, nodes choose a random delay to wait before sending a beacon. *J=0*: The sensors count the number of other transmissions heard while they are waiting to transmit and if the count reaches the value of the activity parameter *K*, then they cancel their own transmission. A node which does not transmit a beacon switches to sleep state. *J=1:* The decision to transmit a beacon and stay awake is made randomly with the probability *K*%. In this way, active nodes are elected for the next cycle through the beacon transmission process. All nodes stay awake if there are requests pending to be relayed. Otherwise, if a node sends a beacon, it becomes active for the next cycle, and if a node fails to send a beacon, it goes to sleep for the next cycle.

The key parameters of the protocol as follows:

T: Beacon period

D: All-awake window duration

W: Number of time-slots for random wait

J, K: Activity mode and activity parameter.

These values are typically set at the command node and included in the request which is broadcast to the sensor nodes and in the beacons transmitted by the sensor nodes.

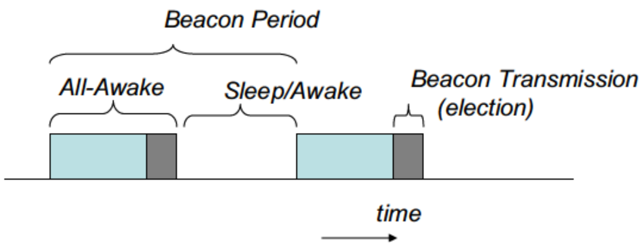

Figure 2: Timing Diagram

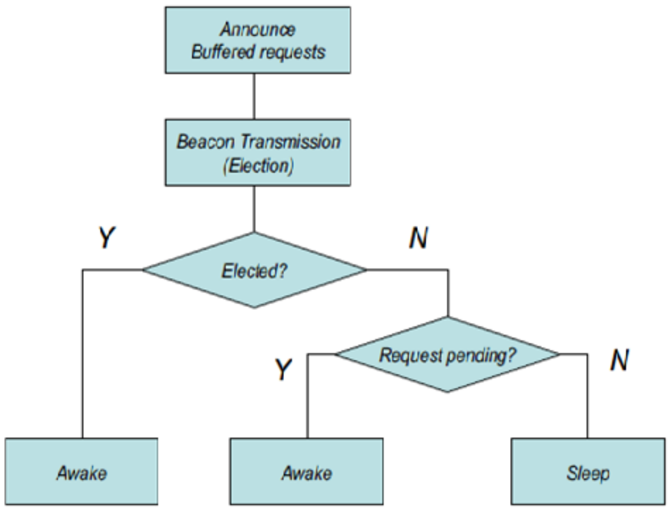

Figure 3: Flowchart for decisions during all-awake window

IV. NETWORK LIFE TIME AND SENSING STRENGTH

Performance characteristics are dependent on activity parameter. In this view, the lifetime and the sensing capacity are key performance characteristics. The system lifetime is the time when all nodes are expected to expire due to battery exhaustion. As activity parameter *K* increases, the system lifetime decreases, roughly as *1/K*. Sensing rate increases with *K*, initially linearly for small *K*, and saturating at higher values. A feature of our protocol is that the value *K* is a parameter which can be included in the request to the sensors. Typically, a low value of *K* can be used as default. Larger values can be commanded as needed to increase the sensing capacity and resolution of the system.

V. CONCLUSIONS

Here the proposed protocol is responsible for managing the spontaneous coordination of sensing activity in group of wireless sensor nodes. A unique feature of our protocol is the use of an activity parameter which can be determined by the user or application, and included in the sensing request issued by the command node. This parameter allows strategic adjustment of the tradeoffs between sensing capacity and other performance characteristics such as operation lifetime. We have shown the applicability of the proposed protocol to a prototype system of sensors which can be used for sensing temperature, allowing temperature data to be collected with varying spatial resolution in an energy efficient way.

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